# Utilization of high-frequency observation of Himawari-8 for satellite rainfall estimation product

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The Global Satellite Mapping of Precipitation (GSMaP) produce global precipitation data with one hour temporal resolution by using microwave radiometer (MWR) on board low-Earth-orbit satellites and Infrared (IR) radiometer on board geostationary meteorological satellites (GEOs). In the GSMaP, the rainfall observed by a MWR is propagating along with the moving vector calculated by GEO IR observations for the interpolation of the gaps in MWR observation coverage. Since the GSMaP rainfall rate complemented with IR algorithms is based on the assumption that deeper clouds are more likely to produce heavy rainfall, conspicuous underestimation of rainfall occurred for heavy precipitation from low-level cloud. Observation bands available for GEO have dramatically increased from the conventional about 3 to 9 after latest GEO called Himawari-8 was launched in October 2014. By using the Himawari-8 IR multi-channel observations, we created high-frequency precipitation data, called Himawari Rainfall Estimation Algorithm (HRA). We used Random Forest (RF) machine learning method to make the HRA and used Ku-band precipitation radar (KuPR) observation of the Global Precipitation Measurement Mission (GPM) core satellite as truth of rain.

We compared estimation results of HRA with radar-AMeDAS rainfall for the case of Kanto Tohoku heavy rain. Radar-AMeDAS observation showed extremely heavy rain from shallow cloud around Kanto region; however, GSMaP could not estimate such heavy rainfall without MWR observations. On the contrary, estimated rainfall intensity of our HRA showed shows good agreement with the radar-AMeDAS result. Furthermore, as a result of statistical analysis, it was found that the 6.9 $\mu$m band played important role to estimate heavy rainfall from shallow cloud, which was sensitive to the lower level water vapor and was newly installed in Himawari-8.

The HRA still have a problem to underestimate the rain rate by approximately 3 mm $h^{-1}$ at maximum compared with the radar–AMeDAS rain rate. Previous studies showed that various indices obtained from the IR channels, such as the CTT minimum, appeared 30–40 min earlier than the occurrence of the first echo of rain observed by the radar (Roberts et al. 2002;, Kondo et al. 2006; Mecikaiski et al. 2006; Walker et al. 2012; and Senf and Deneke 2017). They demonstrated the possibility of detecting convective precipitating clouds earlier and improving the rainfall estimation accuracy using information concerning the development stage of the convective cloud. An advantage of the RF machine-learning method is easy to adopt the above indices. We plan to explain how much estimation accuracy of the HRA improved by incorporating the above indices into the RF model.

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